



## **Climatic conditions related to recent outbreaks of *Neonectria neomacrospora* on *Abies* spp. in Europe and USA**

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# Climatic conditions related to recent outbreaks of *Neonectria neomacrospora* on *Abies* spp. in Europe and USA

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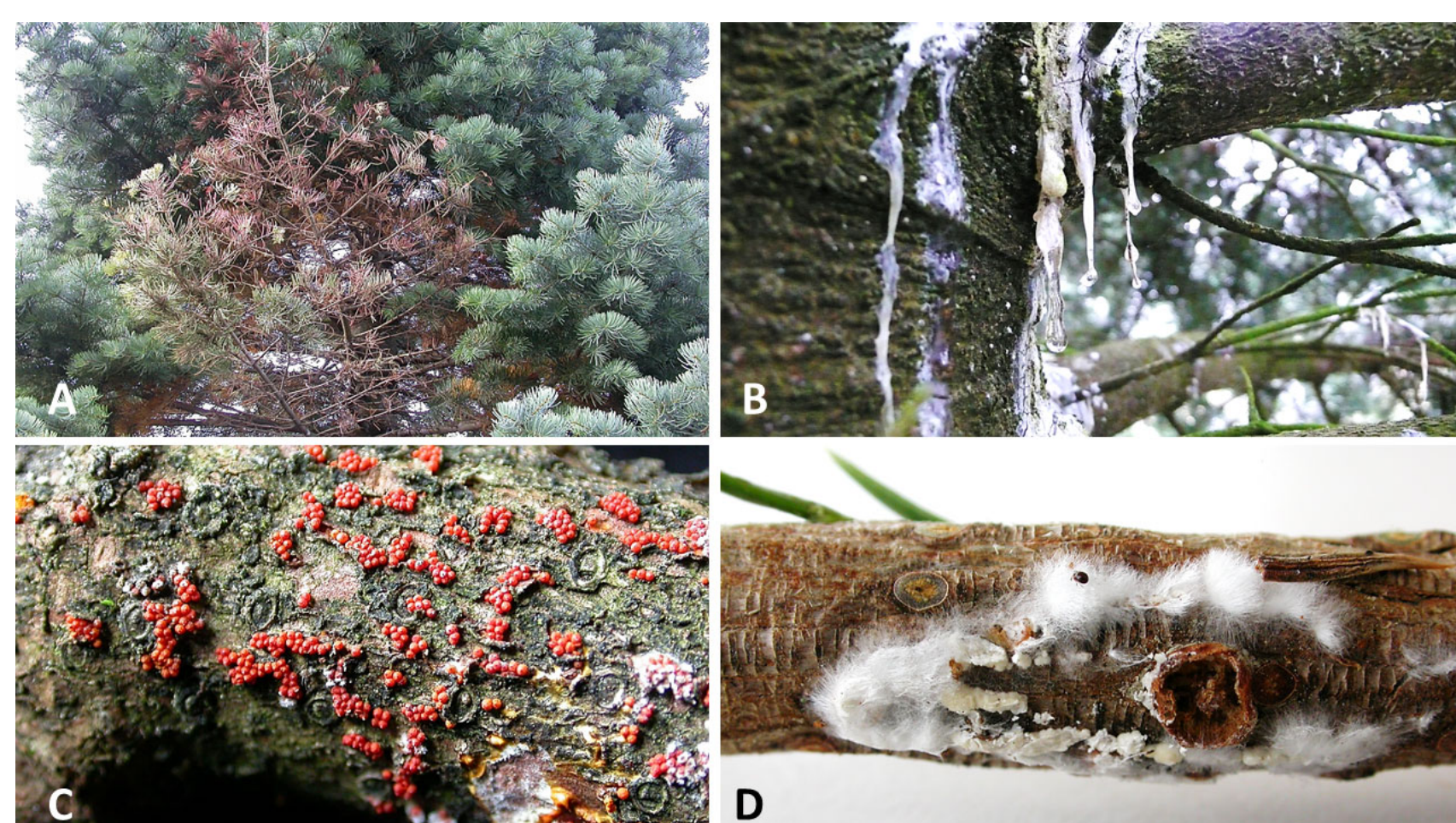


Figure 1. Symptoms and signs of *Neonectria neomacrospora*; dieback of white fir (*Abies concolor*) (A), resin flow on Nordmann fir (*A. nordmanniana*) (B), and perithecia (C) and mycelial growth (D) on subalpine fir (*A. lasiocarpa*). Photos: Venche Talgø

## Neonectria canker

*Neonectria* canker caused by the fungus *Neonectria neomacrospora* (Fig. 1 and 2) has become a severe disease on true fir (*Abies* spp.) in Scandinavia, UK and isolated locations in western USA. The conidia are splash dispersed and may cause local infections within the same tree or neighbouring trees during wet periods. The ascospores are airborne and capable of spreading the fungus over longer distances. The conidial stages of the fungus have been known for over 100 years, but no epidemics like those we have experienced during recent years were reported. Here we present climatic data (temperature and monthly accumulated precipitation) for the last 25 years from five countries where *N. neomacrospora* (*N. n.*) is causing damage, two location per country (blue dots in Fig. 3 and 4 and temperature and precipitation in Fig. 5-14).

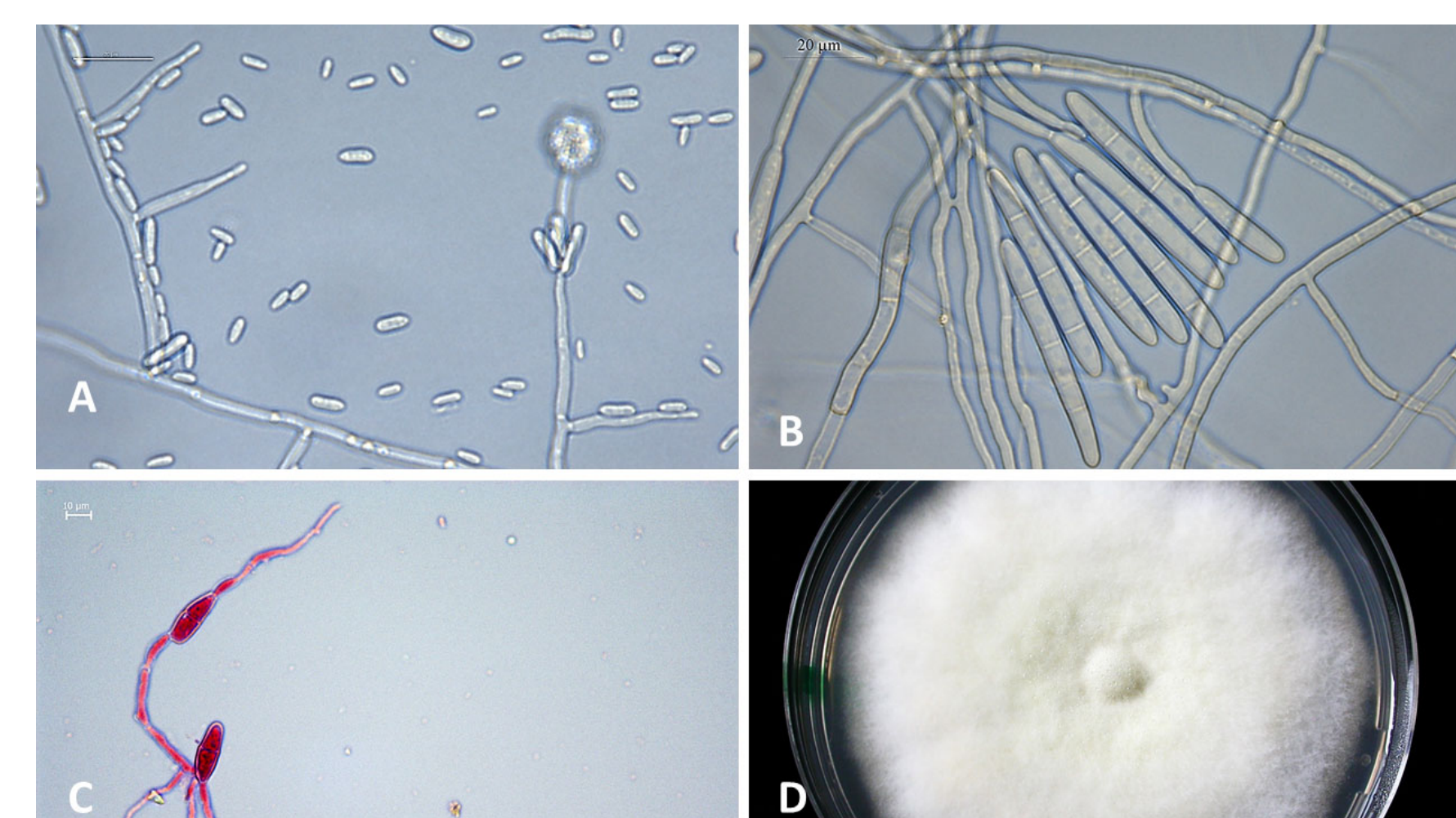


Figure 2. Micro conidia (A), macro conidia (B), germinating ascospores (C), and a culture (D) of *Neonectria neomacrospora*. Photos: Jafar Razzaghian (A, B) and Venche Talgø (C, D)

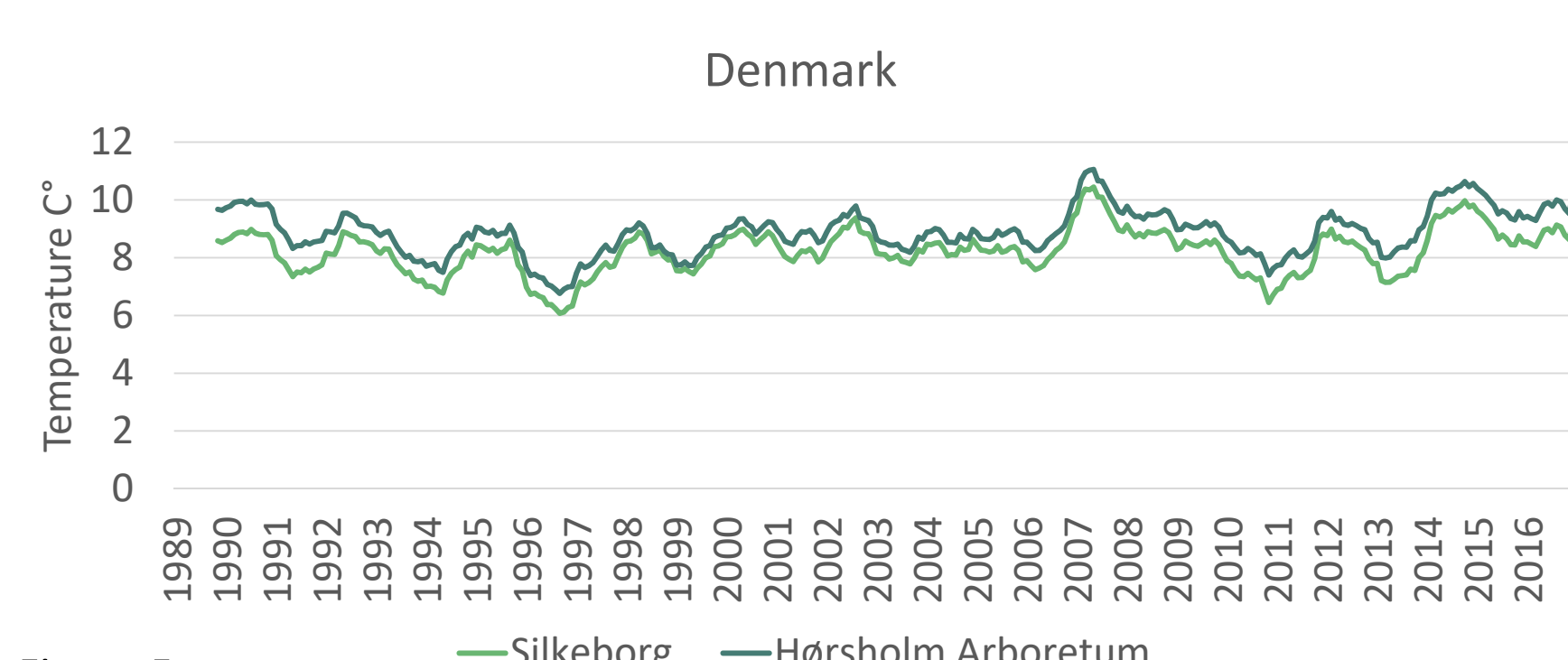


Figure 5. —Silkeborg —Hørsholm Arboretum

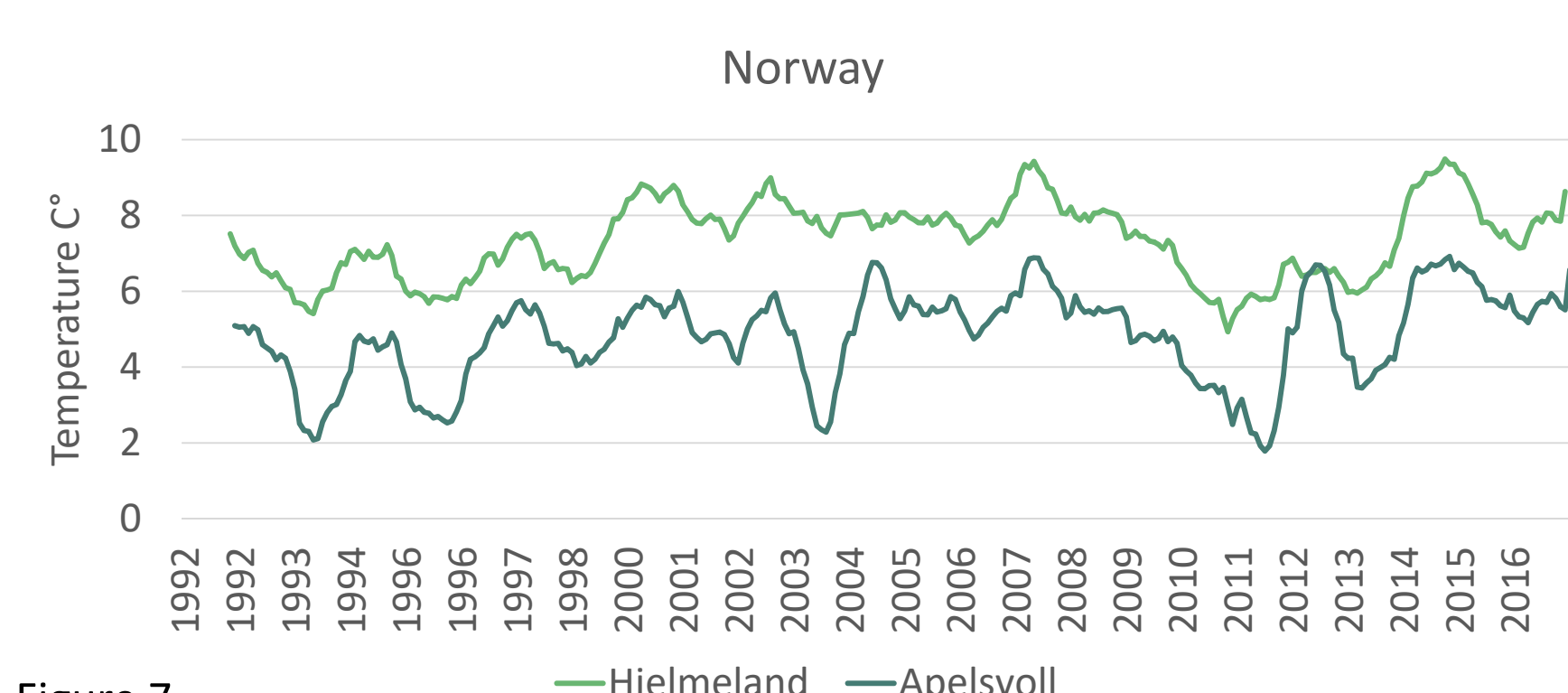


Figure 7. —Hjelmland —Apelsvoll

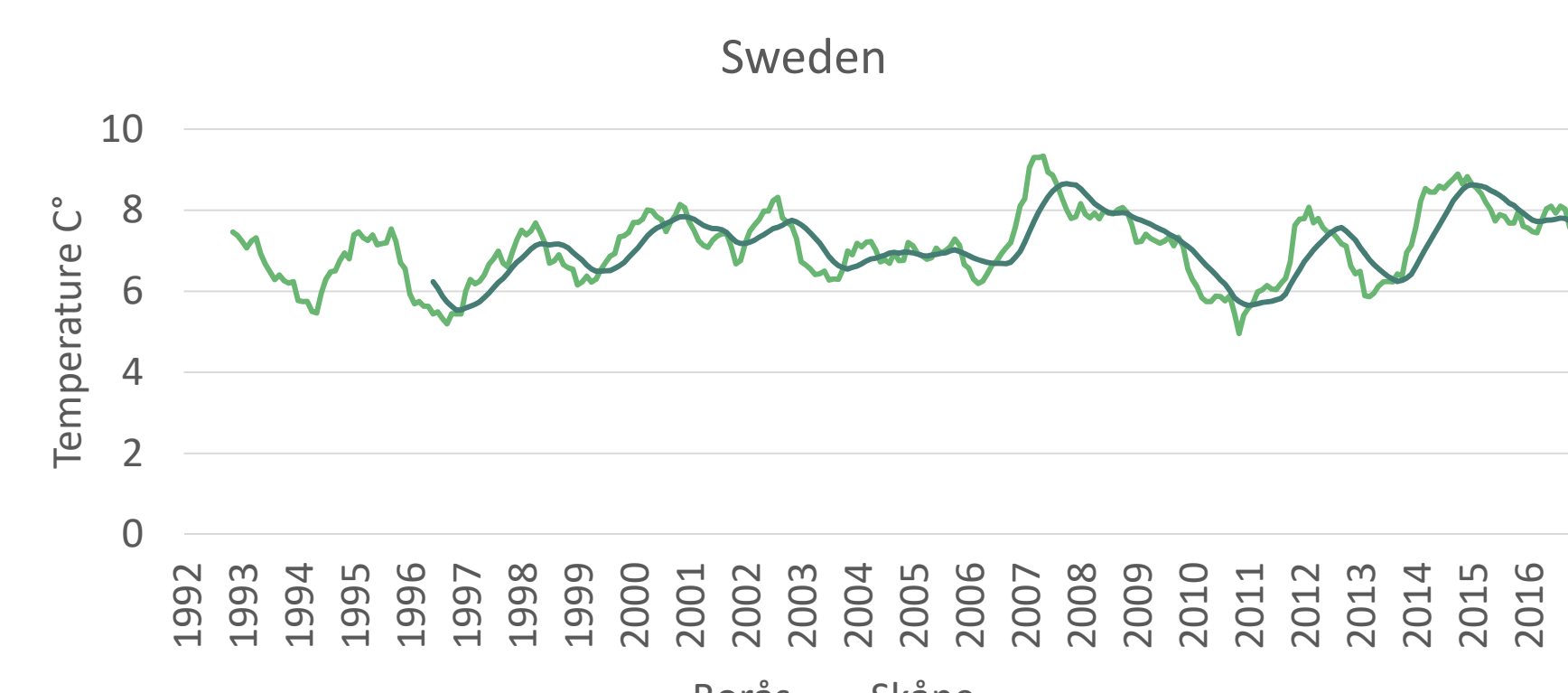


Figure 9. —Borås —Skåne

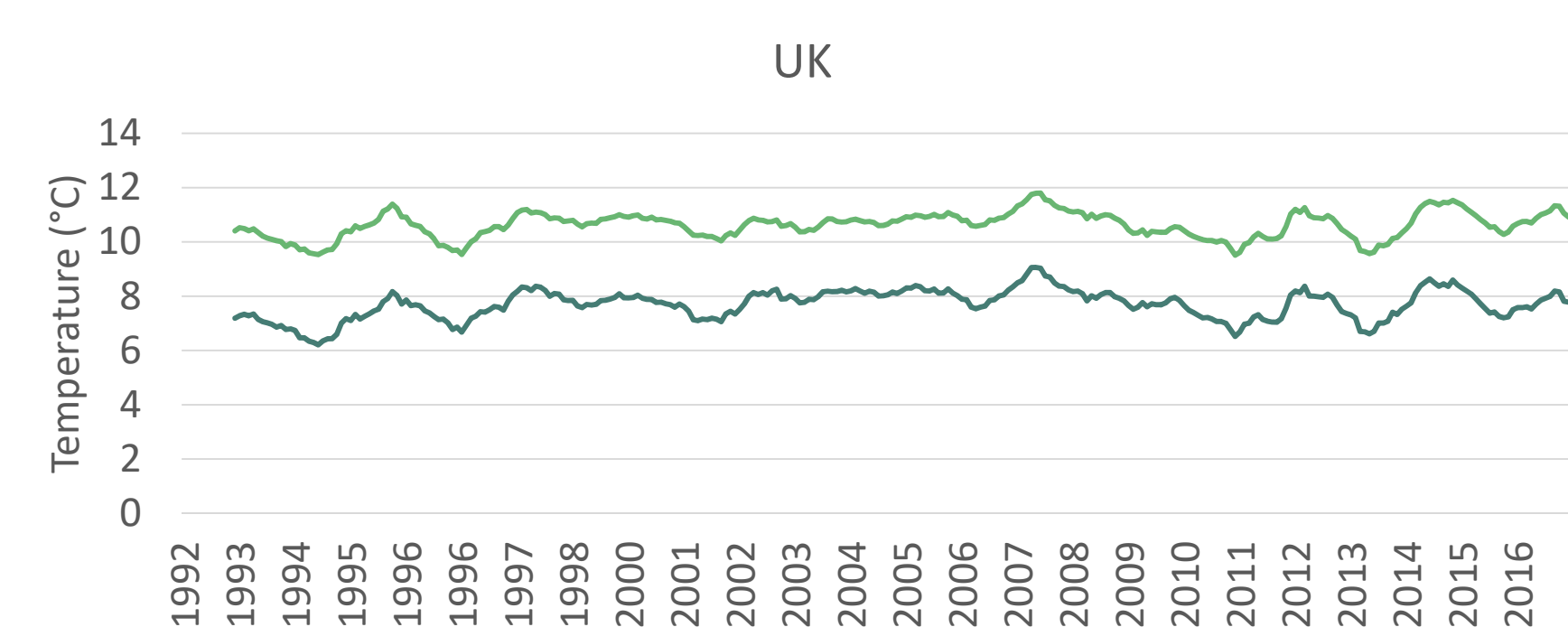


Figure 11. —Valley —Eskdalemuir

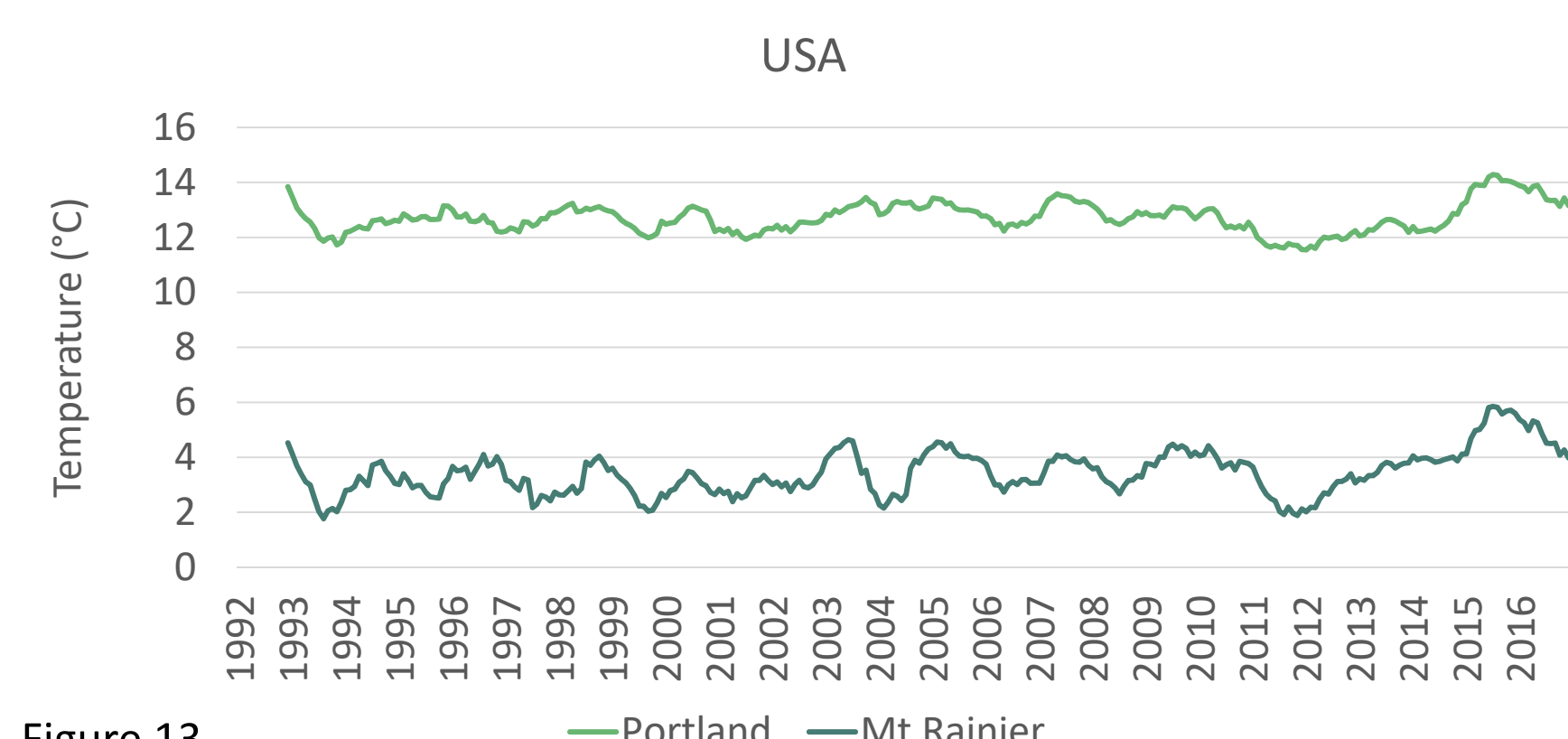


Figure 13. —Portland —Mt Rainier



## Denmark

In 2011, *N. n.* was found for the first time in Denmark on subalpine fir (*A. lasiocarpa*) in a severely affected provenance trial. Later, it was found on different fir species in Danish Christmas tree fields, forest stands, seed orchards, and ornamental plantings where it had caused epidemics and great losses. It was also found on Danish fir seeds and in nurseries (Talgø and Thomsen, unpubl. data; Skulasson 2016; Nielsen et al. 2017).

## Norway

In June 2008, a severe disease outbreak caused by *N. n.* was discovered on white fir (*A. concolor*) in several counties in southern Norway. Later, it was isolated from seven more fir species, Norway spruce (*Picea abies*) and hemlock (*Tsuga heterophylla*) (Talgø et al., unpubl. data). The pathogen was first found in Norway by Robak (1951).

## Sweden

In 2015, a disease survey was carried out at 21 Swedish Christmas tree farms to get an overview of damaging agents. *N. n.* was isolated from dead shoots of Nordmann fir (*A. nordmanniana*) on two farms (Borås). The fungus had not been reported from Sweden before (Pettersson et al. 2016).

## UK

In 2016, *N. n.* was isolated from noble fir (*A. procera*) in a badly damaged forest stand in Valley, Wales (left and right). No *N. n.* was found in Eskdalemuir. (Perez et al., unpubl. data).

Photos: Ana Perez-Sierra

## USA

In 2013, a survey for *N. n.* was carried out in the Pacific Northwest (Oregon, Washington and Idaho) on fir species. Typical symptoms and signs were found on sixteen hosts in western Washington and Oregon (Chastagner et al., unpubl. data).

## Conclusion

Since we do not know the exact starting points of the *N. n.* epidemics, it is hard to determine what impact precipitation and temperature has on disease development. The best documentation we have, is from Norway (Fig. 7, 8 and 15) where the photos in Fig. 16 were taken. During a 10 year span starting in 1996 (Fig. 15), precipitation was above normal from 1997-2000, and the temperature increased, two factors that may have triggered the epidemic. In some locations, such as southern Sweden, lack of inoculum may be limiting disease development. In January 2017, we visited a noble fir stand of 12 ha in southern Sweden (Skåne) where no symptoms of *N. n.* were found.



Figure 16. Subalpine fir (*Abies lasiocarpa*) in a remote forest stand in Breilandslia, Hjelmland, Norway. The trees were planted in 1967. In 1997 they were completely healthy (left), but in 2007 trees were dead and dying from *Neonectria neomacrospora* (right). Photos: Terje Pundsnes

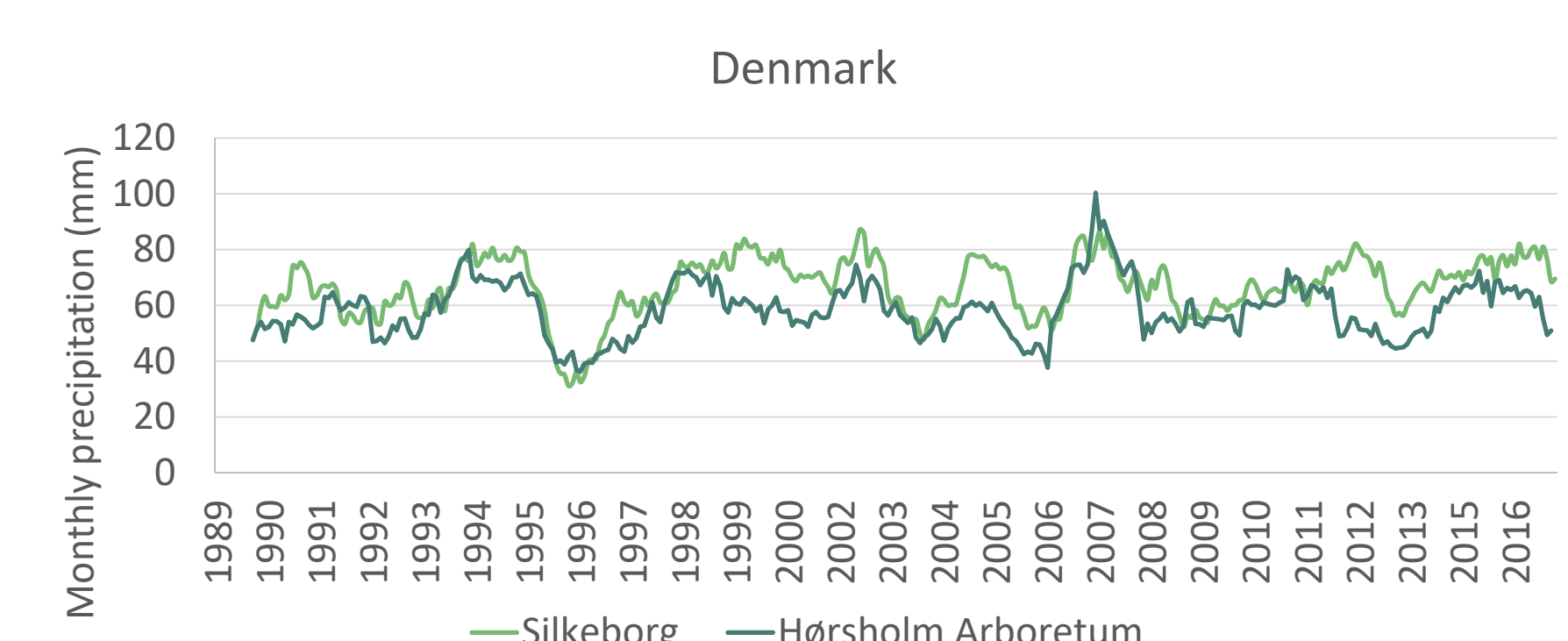


Figure 6. —Silkeborg —Hørsholm Arboretum

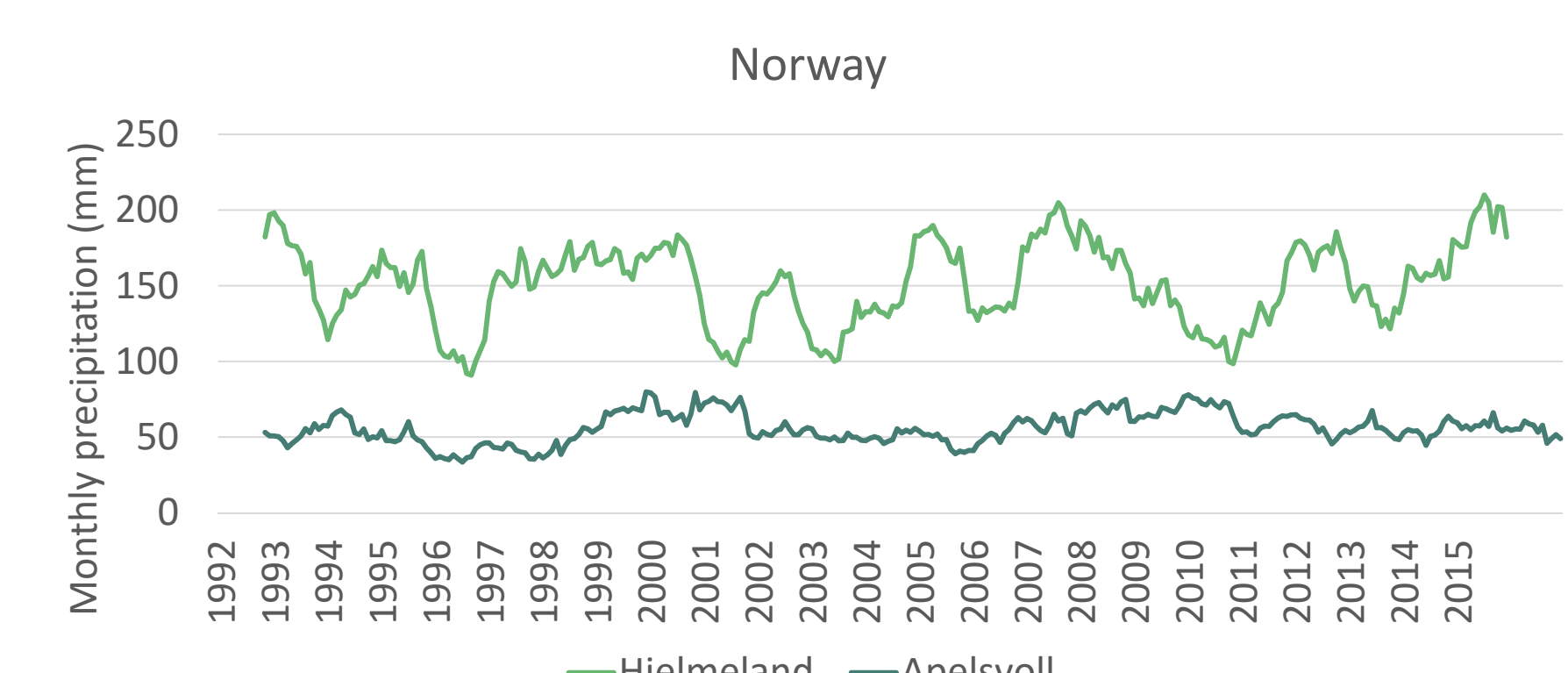


Figure 8. —Hjelmland —Apelsvoll

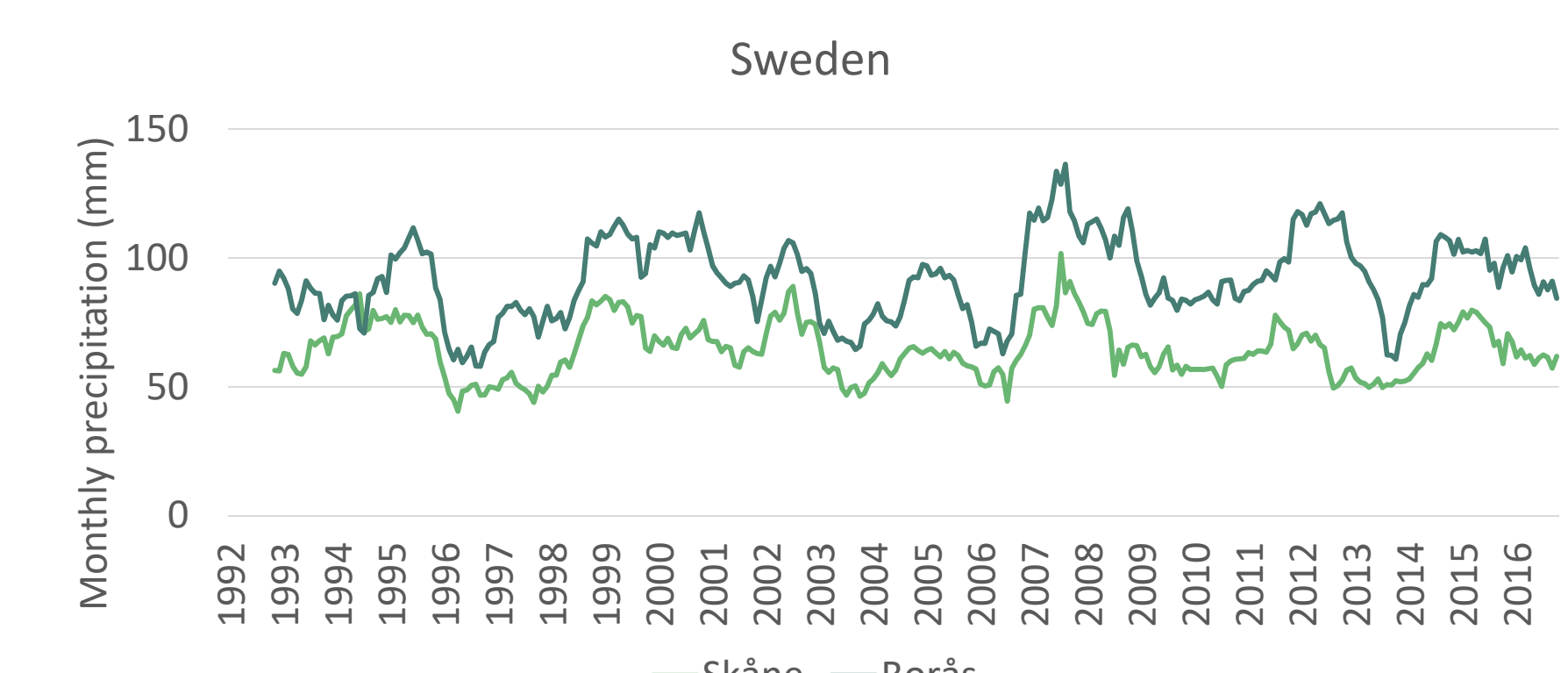


Figure 10. —Skåne —Borås

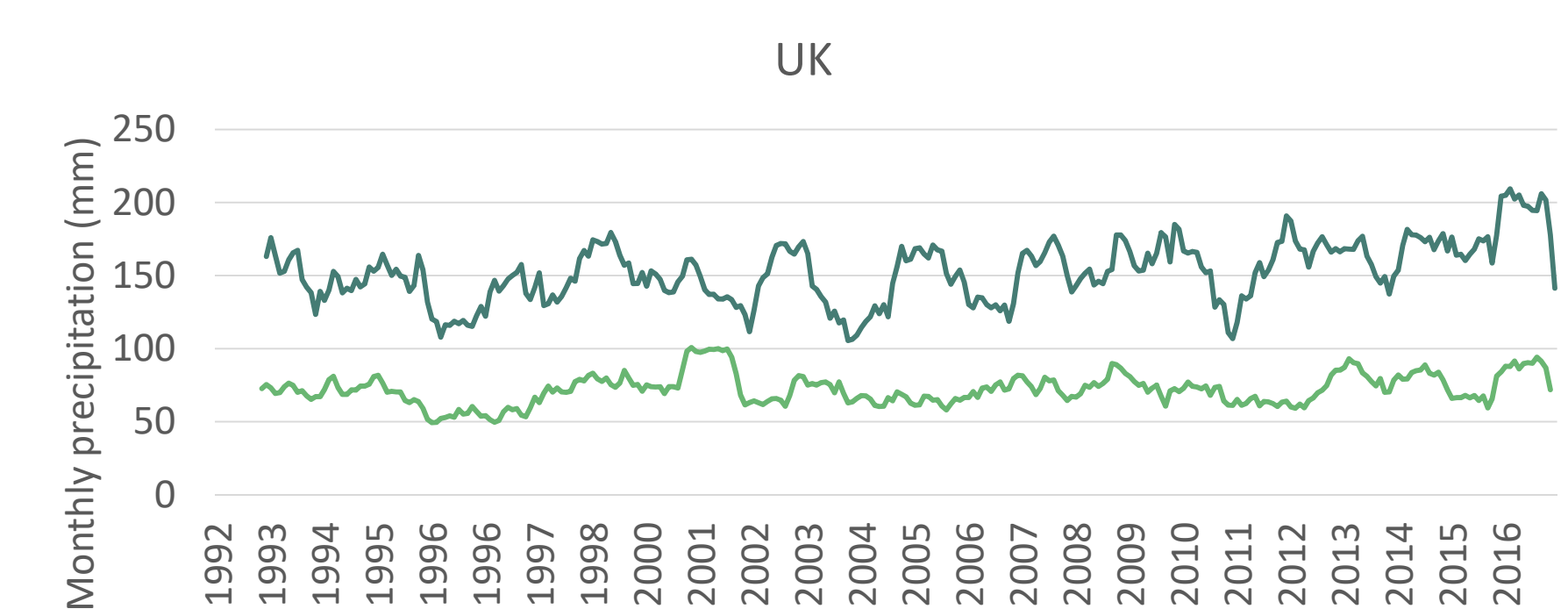


Figure 12. —Valley —Eskdalemuir

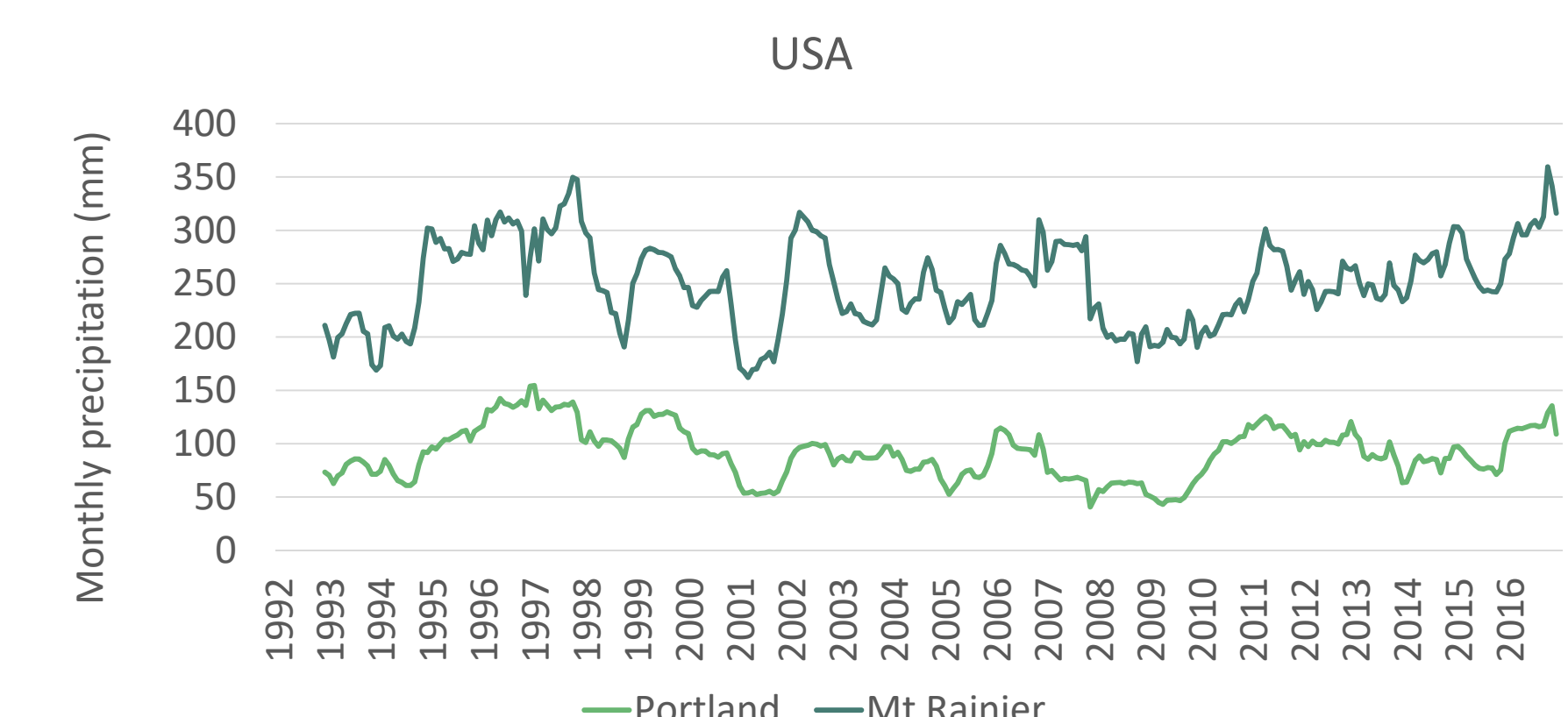


Figure 14. —Portland —Mt Rainier

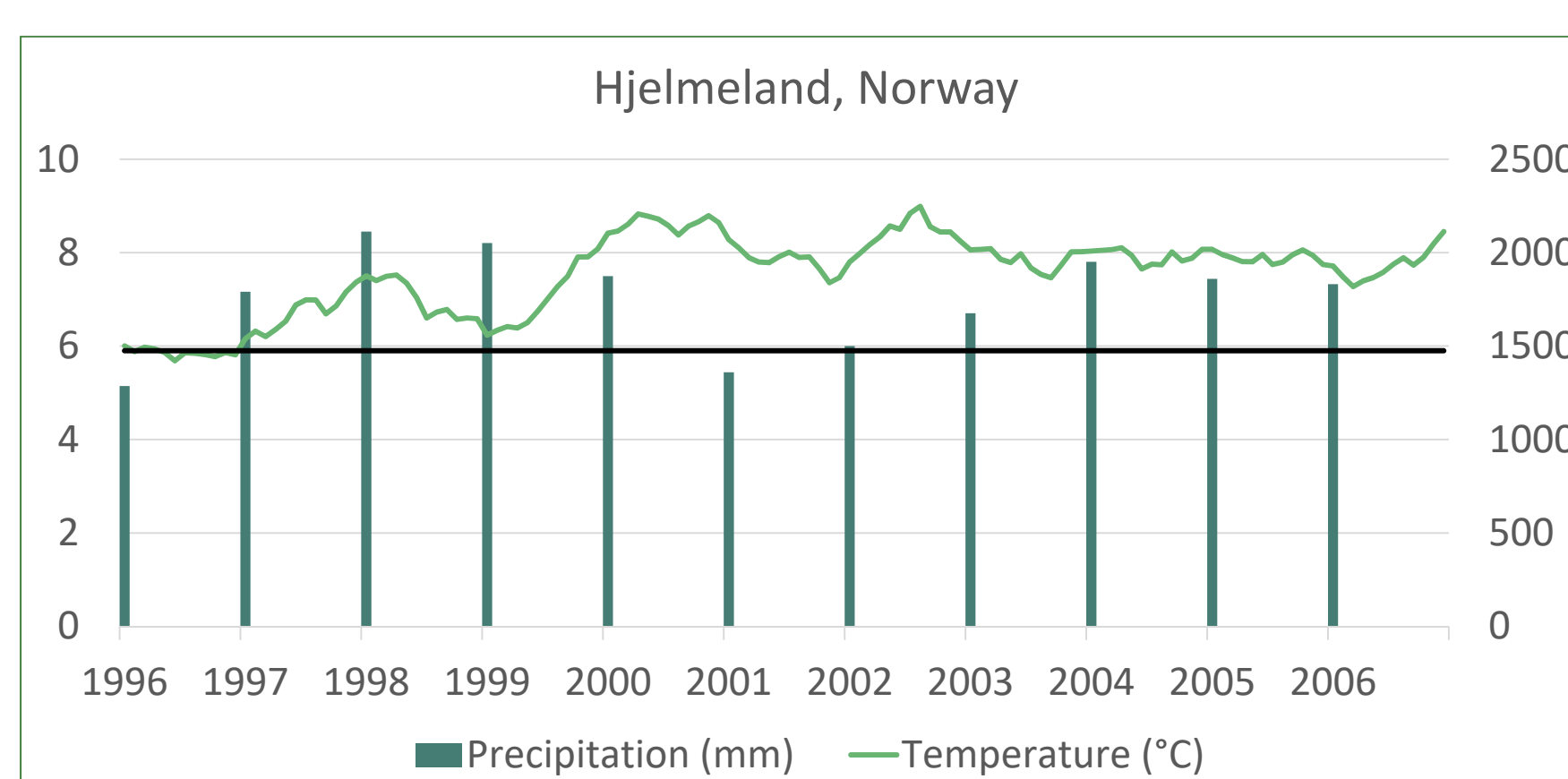


Figure 15. The black, horizontal line shows the 30-year normal precipitation (scale for temperature to the left and precipitation to the right).

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